*Title:* **Assimilation of satellite-derived skin temperature observations into land surface models, Journal of Hydrometeorology (American Meteorological Society)**

*Author list w/ email addresses:*

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| R. H. Reichle | Rolf.Reichle@nasa.gov |
| S. V. Kumar | Sujay.V.Kumar@nasa.gov |
| S. P. P. Mahanama | Sarith.P.Mahanama@nasa.gov |
| R. D. Koster | Randal.D.Koster@nasa.gov |
| Q. Liu | Qing.Liu@nasa.gov |

*Abstract:*

Land surface (or "skin") temperature (LST) lies at the heart of the surface energy balance and is a key variable in weather and climate models. Here we assimilate LST retrievals from the International Satellite Cloud Climatology Project (ISCCP) into the Noah and Catchment (CLSM) land surface models using an ensemble-based, off-line land data assimilation system. LST is described very differently in the two models. A priori scaling and dynamic bias estimation approaches are applied because satellite and model LST typically exhibit different mean values and variability. Performance is measured against 27 months of in situ measurements from the Coordinated Energy and Water Cycle Observations Project at 48 stations. LST estimates from Noah and CLSM without data assimilation ("open loop") are comparable to each other and superior to that of ISCCP retrievals. For LST, RMSE values are 4.9 K (CLSM), 5.6 K (Noah), and 7.6 K (ISCCP), and anomaly correlation coefficients (R) are 0.62 (CLSM), 0.61 (Noah), and 0.52 (ISCCP). Assimilation of ISCCP retrievals provides modest yet statistically significant improvements (over open loop) of up to 0.7 K in RMSE and 0.05 in anomaly R. The skill of surface turbulent flux estimates from the assimilation integrations is essentially identical to the corresponding open loop skill. Noah assimilation estimates of ground heat flux, however, can be significantly worse than open loop estimates. Provided the assimilation system is properly adapted to each land model, the benefits from the assimilation of LST retrievals are comparable for both models.

*Popular Summary:*

The temperature of the land surface lies at the heart of the surface energy balance and can be measured from satellite. Land surface temperature (LST) is also a key variable in weather and climate models and can be obtained by using estimates of land surface characteristics (such as topography, vegetation, and soil information) along with precipitation (and other surface meteorological information) in a numerical model of land surface processes. The land surface model keeps track of the water and energy balance at the land surface and thereby also estimates its temperature. Due to the characteristics of the satellite instruments and the land surface models, however, the temperature estimates are subject to errors. Moreover, the temperatures described by the satellite estimates and land surface models are not perfectly equivalent. These unavoidable differences make it difficult to merge satellite and model estimates in a so-called data assimilation system in

order to extract the maximum amount of information from all sources.

Here we assimilate satellite estimates of LST from the International Satellite Cloud Climatology Project (ISCCP) into the Noah and Catchment land surface models using an ensemble-based land data assimilation system. The two land surface models are used in the weather and climate forecasting systems at NOAA and NASA, respectively. We developed a customized approach for LST that helps bridge the conceptual differences between satellite and model estimates before and during the data assimilation procedure. The performance of the satellite, model, and assimilation estimates is measured against 27 months of in situ measurements from the Coordinated Energy and Water Cycle Observations Project at 48 stations distributed around the globe. LST estimates from the Noah and Catchment models without data assimilation are comparable to each other and superior to that of satellite estimates. Assimilation of the satellite estimates provides modest yet statistically significant improvements (over the model estimates) of up to 0.7 Kelvin (in terms of the root-mean square error). The skill of land-atmosphere flux estimates from the assimilation integrations is essentially identical to the corresponding model skill. Assimilation estimates of heat flux into the ground from the Noah land surface model, however, can be significantly worse than Noah model estimates. Provided the assimilation system is properly adapted to each land model, the benefits from the assimilation of satellite estimates of LST are comparable for both land surface models.